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INYOITE FROM NEW BRUNSWICK

by

Eugene Poitevin

and

H. V. Ellsworth

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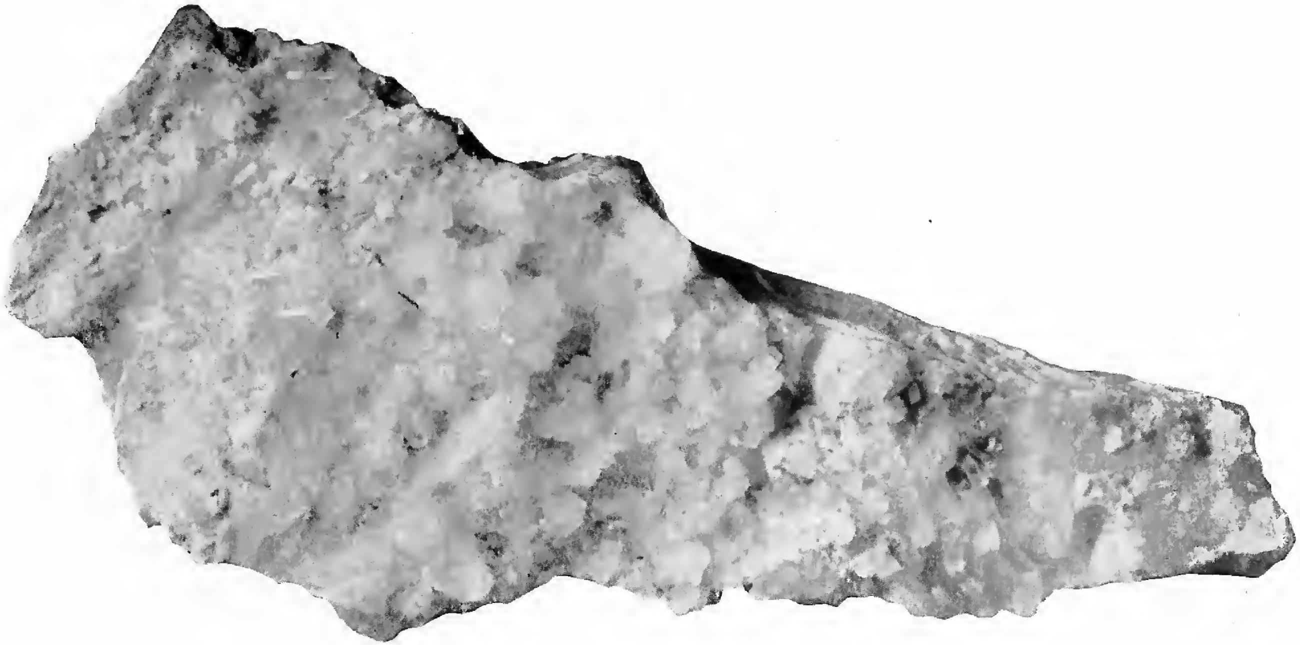

Specimen of mass of gypsum coated with crystals of inyoite and selenite, from Hillsborough, N.B.
Approximate length, 45 centimetres. (Page 1.)

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INYOITE FROM NEW BRUNSWICK.

By EUGENE POITEVIN and H. V. ELLSWORTH.

INTRODUCTION.

During the course of a collecting trip in New Brunswick in the summer of 1916, A. T. McKinnon of the Geological Survey paid a visit to the Whitehead gypsum quarry, Hillsborough, Albert county, where there was brought to his notice a specimen which had attracted attention by reason of a beautiful arrangement of crystals covering one of its surfaces.

The specimen is roughly a three-sided pyramid approximately 45 centimetres in length. Two of the basal edges measure approximately 22 centimetres, the third edge about 16 centimetres.

The most abundant mineral constituent of the specimen is a greyish-white, fairly compact, gypsum, but on the narrowest face of the pyramid there is an abundant crystal development which imparts to the specimen a very striking and handsome appearance.

Its general aspect, as illustrated by Plates I and II, gives the impression that it represents a portion of the wall of a cavity or fissure of perhaps considerable dimensions.

A more intimate examination of the specimen showed that in addition to the larger development of crystals on one surface groups of smaller crystals are to be found filling, wholly or in part, veinlets and vugs in other portions of the gypsum (Plate III).

Some of the crystals having prismatic habit proved on examination to be selenite; the largest of these measured from 2 to 2½ centimetres in length by half a centimetre in thickness; some are simple individuals showing the combination of the clinopinacoid, the unit prism, the unit pyramid, and the negative orthodome e($\bar{1}03$); in some cases twins were observed consisting of two individuals joined parallel with the orthopinacoid. The following forms have been observed: c(001), a(100), b(010), h(120), g(230), δ(350), f(110), l(111), e($\bar{1}03$). In general the prismatic faces show vertical striations; these are particularly abundant on f(110).

Along with the selenite crystals, and sometimes superposed upon them, are numbers of white, translucent crystals which, as shown by physical and chemical examinations made by the authors, agree with the inyoite, described by Schaller,[1] from Death Valley, California. The occurrence now under consideration constitutes the second so far recorded for this species.

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[1] U. S. Geol. Surv., Bull. 610, ser. 3, pp. 35–40.

CRYSTALLOGRAPHY.

Schaller states in his paper on the inyoite from the California locality that the species crystallizes in the monoclinic system and gives as the axial ratios for a: b: c:$=0\cdot9408:1:0\cdot6665$ $\beta=62° 37'$. The crystals which he examined showed the following forms: c(001), b(010), m(110), p(111); they were, however, not sufficiently bright to give good reflections, and Schaller's figures are based on measurements effected with a contact goniometer. And in a paper published some time later A. F. Rogers gives [1] the results of some studies of colemanite pseudomorphs after inyoite found in Death Valley, California, from which he deduces the following axial ratios: a:b:c$=0\cdot90:1:0\cdot63$. $\beta=65°$. The pseudomorphous crystals examined by Rogers showed the same forms as did the inyoite examined by Schaller.

The crystals of inyoite from Hillsborough are remarkably well developed and clear and, with rare exceptions, doubly terminated. They are rich in forms giving in most instances excellent reflections. It was noted, however, that handling with the naked fingers occasioned immediate deterioration in

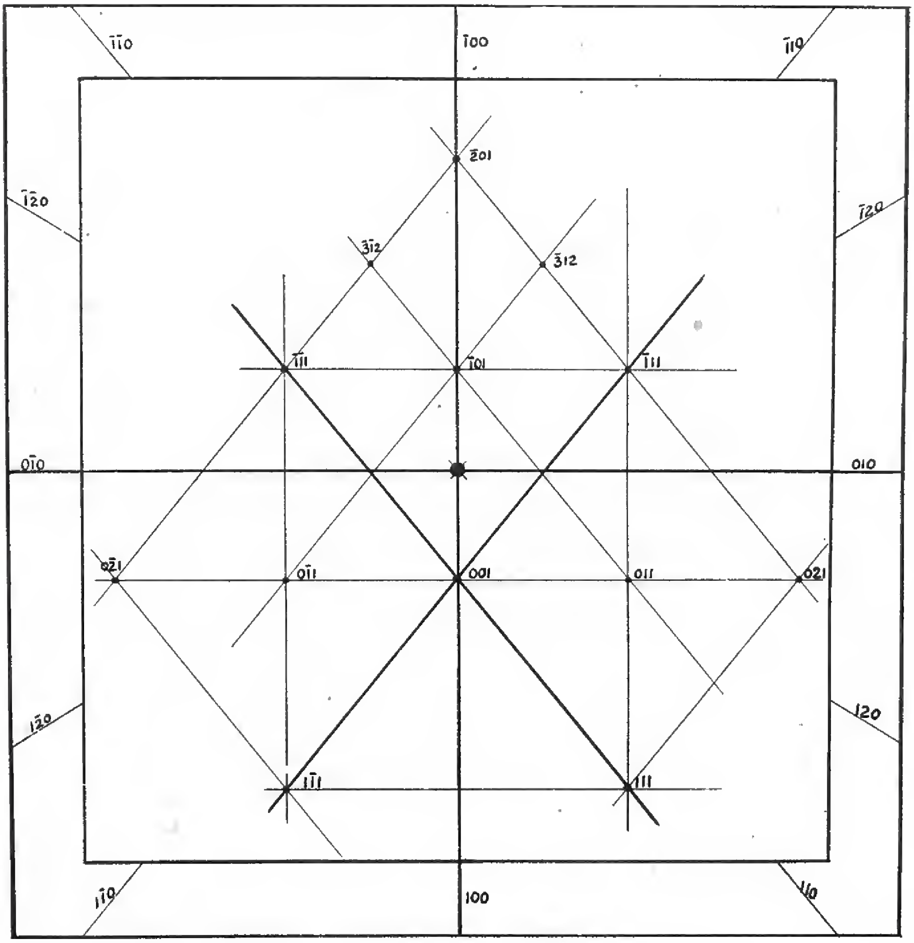

FIGURE 1. Gnomonic[1] projection showing distribution of faces on inyoite from Hillsborough, N.B.

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[1] The Am. Miner, vol. 4, No. 11, Nov., 1919, pp. 135–139.

this regard owing to fritting caused by exudations from the skin. Nineteen selected individuals were separated from the matrix and measured on the two-circle goniometer and many others were studied under a binocular microscope once the crystal habit had been established. The measurements were carried along the principal zones and the orientation finally adopted is the same as that proposed by Schaller, and represented by the following gnomonic projection.

This projection affirms the monoclinic character of the crystals as originally established by Schaller upon his California specimens. Twelve forms have been identified on crystals from Hillsborough—basal pinacoid, four prisms, two negative orthodomes, two clinodomes, and three pyramids. The zonal relations are extremely well defined and, apart from two of the domes, all the forms fall within the area limited by the unit pyramid.

Calculation of the Elements.

The crystals of inyoite from Hillsborough being characterized by well-developed forms perfectly adapted to measurement by the reflecting goniometer, it is not surprising that measurements made upon them show some differences from those made by Schaller upon cruder crystals with the contact goniometer.

For the purpose of calculating the elements only such angular measurements as have been obtainable between faces showing very good reflection are employed. These measurements are, therefore, restricted to seven crystals showing the greatest measure of excellence.

Averages of Measured Angles of Inyoite (very good reflections).

Forms	φ	ρ
c(001)	90° 00′	24° 11′
b(010)	00° 00′	90° 00′
a(100)	90° 00′	90° 00′
m(110)	51° 02′	90° 00′
z(120)	31° 52′	90° 00′
k(011)	32° 44′	39° 27′
v(021)	17° 46′	55° 40′
i($\bar{1}$01)	$\overline{90}$° 00′	22° 32′
h($\bar{2}$01)	$\overline{90}$° 00′	52° 04′
p(111)	62° 02′	55° 57′
y($\bar{1}$11)	$\overline{31}$° 14′	39° 05′
g($\bar{3}$12)	$\overline{67}$° 40′	42° 25′

From the above, seven equations were formed as follows:

(A) p(111) $X' = 1{\cdot}30690 = \underset{\circ}{p}' + e'$ for 8 values of X'
(B) y($\bar{1}$11) $X' = -0{\cdot}42113 = -\underset{\circ}{p}' + e'$ for 4 values of X'
(C) i($\bar{1}$01) $X' = -0{\cdot}41489 = -\underset{\circ}{p}' + e'$ for 2 values of X'
(D) h($\bar{2}$01) $X' = -1{\cdot}28300 = -2\underset{\circ}{p}' + e'$ for 4 values of X'
(E) c(001) $X' = 0{\cdot}44906 = e'$ for 7 values of X'
(F) v(021) $X' = 0{\cdot}44676 = e'$ for 5 values of X'
(G) k(011) $X' = 0{\cdot}44495 = e'$ for 2 values of X'

The above equations were solved in pairs:

(A) and (B)	$e'=0{\cdot}44288$	$p'_o=0{\cdot}86402$
(A) and (C)	$e'=0{\cdot}44600$	$p'_o=0{\cdot}86090$
(A) and (D)	$e'=0{\cdot}44360$	$p'_o=0{\cdot}86330$
(A) and (E)	$e'=0{\cdot}44906$	$p'_o=0{\cdot}85784$
(A) and (F)	$e'=0{\cdot}44676$	$p'_o=0{\cdot}86014$
(A) and (G)	$e'=0{\cdot}44495$	$p'_o=0{\cdot}86195$
	$e'=0{\cdot}44554$	$p'_o=0{\cdot}86136$

Cotg $\mu=e'$; $\mu=65°\ 59'$; $\beta=114°\ 01'$

$h=\sin\mu$; $h=0{\cdot}91341$

$e=e'\sin\mu=\cos.\ \mu=0{\cdot}40700$

$p_o=p'_o\sin\mu=0{\cdot}78678$

In the same way q was found using equations A, B, F, G.

(A)	p(111)	$y'=0{\cdot}69394=q'_o$	for 8 values of Y'
(B)	y($\bar{1}$11)	$y'=0{\cdot}69446=q'_o$	for 4 values of Y'
(F)	v(021)	$y'=1{\cdot}39425=2q'_o$	for 5 values of Y'
(G)	k(011)	$y'=0{\cdot}69218=q'_o$	for 2 values of Y'
		$q'_o=0{\cdot}69496$	

$q_o=q'_o\sin\mu$; $q_o=0{\cdot}63478$

$c=q'_o=0{\cdot}69496$

$b=1$

$a=\dfrac{q'_o}{p_o}=0{\cdot}88329$

$a_o=1{\cdot}2708$

$b_o=1{\cdot}4389$

$c_o=1$

The measurements from which these elements were calculated are given below:

Measurements of c(001) Inyoite.

No.	Crystals	Reflections	Size of face	ρ
1	6	a[1]	large	24° 59'
2	19	a	large	23° 59'
3	3	a	medium	24° 15'
4	1	a	medium	24° 10'
5	2	a	large	24° 17'
6	4	a	large	24° 33'
7	9	a	large	24° 04'
	Average of seven very good reflections			24° 11'
			Calculated	24° 01'

---

[1] a Very good reflections.

Measurements of z(120) Inyoite.

No.	Crystals	Reflections	Size of face	φ
1	6	a[1]	long narrow	31° 57′
2	6	a	“	31° 46′
3	6	a	“	31° 49′
4	6	d	line face	32° 07′
5	19	c	long narrow	32° 34′
6	19	c	“	32° 03′
7	19	b	“	31° 45′
8	3	a	“	31° 57′
9	2	a	“	31° 44′
10	4	c	“	32° 02′
11	4	c	“	31° 09′
12	9	d	“	31° 36′
13	9	a	“	32° 01′
	Average of 13 measurements			31° 53′
	Average of 6 very good reflections			31° 52′
	1 good reflection			31° 45′
	Average of 4 fair reflections			31° 57′
	Average of 2 poor reflections			31° 51′
	Calculated			31° 47′

[1] a Very good reflections.
b Good reflections.
c Fair reflections.
d Poor reflections.

Measurements of p(111) Inyoite.

No.	Crystals	Reflections	Size of face	φ	ρ
1	4	a	large	61°44′	55°43′
2	4	b	“	61°44′	55°43′
3	6	a	long narrow	62°09′	55°44′
4	6	a	medium	61°55′	55°44′
5	19	b	long narrow	62°24′	55°51′
6	19	b	medium	62°33′	55°26′
7	3	c	small	62°08′	56°01′
8	1	a	medium	61°57′	56°13′
9	1	a	“	62°03′	56°13′
10	9	a	“	62°07′	55°58′
11	9	a	“	62°18′	55°58′
12	2	a	“	62°09′	56°00′
	Average of 12 measurements			62°06′	55°53′
	Average of 8 very good reflections			62°02′	55°57′
	Average of 3 good reflections			62°13′	55°40′
	1 fair reflection			62°08′	56°01′
	Calculated			62°00′	55°57′

Measurements of y($\bar{1}11$) Inyoite.

No.	Crystals	Reflections	Size of face	φ	ρ
1	6	b	long narrow	$\overline{32}$°21′	39°51′
2	19	d	“	$\overline{31}$°09′	38°41′
3	19	d	“	$\overline{30}$°46′	38°41′
4	3	a	“	$\overline{30}$°51′	39°03′
5	3	a	“	$\overline{31}$°38′	39°03′
6	1	a	“	$\overline{30}$°56′	39°09′
7	1	c	“	$\overline{31}$°06′	39°09′
8	2	a	“	$\overline{31}$°30′	39°06′
9	4	c	“	$\overline{30}$°53′	38°45′
10	9	b	“	$\overline{31}$°04′	39°10′
	Average of 10 measurements			$\overline{31}$°13′	39°04′
	Average of 4 very good reflections			$\overline{31}$°14′	39°05′
	Average of 2 good reflections			$\overline{31}$°42′	39°30′
	Average of 2 fair reflections			$\overline{30}$°59′	38°57′
	Average of 2 poor reflections			$\overline{30}$°57′	38°41′
	Calculated			$\overline{30}$°54′	39°00′

Measurements of m(110) Inyoite.

No.	Crystals	Reflections	Size of face	φ
1	6	a	large	51°10′
2	6	a	“	50°29′
3	6	a	“	50°29′
4	6	a	“	51°14′
5	19	a	“	51°16′
6	19	a	“	51°46′
7	19	b	“	51°34′
8	19	a	“	51°17′
9	3	c	“	50°59′
10	3	a	“	51°08′
11	1	c	“	51°36′
12	1	c	“	51°06′
13	1	b	“	51°09′
14	2	a	“	50°59′
15	4	b	“	50°58′
16	4	d	“	50°06′
17	4	d	“	50°09′
18	9	a	“	51°04′
19	9	a	“	51°16′
20	9	a	“	51°43′
21	9	a	“	51°24′
	Average of 21 measurements			50°56′
	Average of 13 very good reflections			51°02′
	Average of 3 good reflections			51°13′
	Average of 3 fair reflections			51°10′
	Average of 2 poor reflections			50°07′
	Calculated			51°06′

Measurements of i($\bar{1}01$) Inyoite.

No.	Crystals	Reflections	Size of face	φ	ρ
1...........	6	a	long narrow	$\overline{90}$°00′	22°44′
2...........	19	d	"	"	22°40′
3...........	3	a	small	"	22°21′
4...........	1	d	small	"	22°26′
5...........	4	b	medium	"	22°15′
	Average of 5 measurements...............			$\overline{90}$°00′	22°29′
	Average of 2 very good reflections.........			"	22°32′
	1 good reflection.........................			"	22°15′
	Average of 2 poor reflections.............			"	22°33′
	Calculated.............................			"	22°34′

Measurements of h($\bar{2}01$) Inyoite.

No.	Crystals	Reflections	Size of face	φ	ρ
1...........	6	a	medium	$\overline{90}$°00′	52°15′
2...........	19	b	"	"	52°08′
3...........	3	a	small	"	51°57′
4...........	1	b	medium	"	52°06′
5...........	2	a	"	"	52°00′
6...........	4	b	small	"	51°39′
7...........	9	a	medium	"	52°03′
	Average of 7 measurements...............			$\overline{90}$°00′	52°01′
	Average of 4 very good reflections.........			"	52°04′
	Average of 3 good reflections..............			"	51°57′
	Calculated.............................			"	51°57′

Measurements of k(011) Inyoite.

No.	Crystals	Reflections	Size of face	φ	ρ
1...........	3	c	line	32°10′	40°11′
2...........	19	b	small	32°34′	39°11′
3...........	19	b	"	33°02′	39°11′
4...........	6	b	"	32°42′	39°51′
5...........	1	a	"	32°44′	39°19′
6...........	1	b	"	33°26′	39°19′
7...........	2	a	"	32°44′	39°36′
8...........	9	c	"	31°52′	40°34′
	Average of 8 measurements..............			32°39′	39°39′
	Average of 2 very good measurements.....			32°44′	39°27′
	Average of 4 good reflections..............			32°56′	39°23′
	Average of 2 fair reflections...............			32°01′	40°22′
	Calculated.............................			32°40′	39°33′

Measurements of g($\bar{3}12$) Inyoite.

No.	Crystals	Reflections	Size of face	φ	ρ
1	D	a	small	$\overline{67}$°40′	42°25′
	Calculated			$\overline{67}$°41′	42°28′

Measurements of v(021) Inyoite.

No.	Crystal	Reflection	Size of face	φ	ρ
1	6	a	medium	17°42′	55°36′
2	19	b	small	17°48′	55°40′
3	19	b	"	17°54′	55°40′
4	3	a	"	17°47′	55°41′
5	3	a	"	17°47′	55°41′
6	1	b	"	17°48′	55°36′
7	1	b	"	17°47′	55°36′
8	2	a	"	17°47′	55°39′
9	4	d	"	17°47′	55°21′
10	9	a	"	17°48′	55°43′
	Average of 10 measurements			17°47′	55°37′
	Average of 5 very good reflections			17°46′	55°40′
	Average of 4 good reflections			17°49′	55°38′
	1 fair reflection			17°47′	55°21′
	Calculated			17°46′	55°36′

From the above measurements and calculations the table below has been constructed according to the plan followed by V. Goldschmidt in his Winkeltabellen.

Inyoite from Hillsborough, New Brunswick. Monoclinic.

$a = 0{\cdot}88329$	$\log a = 994610$	$\log a_o = 10{\cdot}10407$	$\log p_o = 989585$	$a_o = 1{\cdot}2708$	$p_o = 0{\cdot}78678$	$p_o' = 0{\cdot}86136$	$\log p_o' = 993518$
$c = 0{\cdot}69496$	$\log c = 984195$	$\log b_o = 10{\cdot}15803$	$\log q_o = 980262$	$b_o = 1{\cdot}4389$	$q_o = 0{\cdot}63478$	$q_o' = 0{\cdot}69496$	$\log q_o' = 984195$
$\left.\begin{matrix}\mu = \\ 180-\beta\end{matrix}\right\} = 65^\circ 59'$	$\left.\begin{matrix}\log h = \\ \log \mu\end{matrix}\right\} = 996067$	$\left.\begin{matrix}\log e' = \\ \log \operatorname{cotg} \mu\end{matrix}\right\} = 964888$	$\log \frac{p_o}{q_o} = 10{\cdot}09321$	$h = 0{\cdot}91341$	$e = 0{\cdot}40700$	$e' = 0{\cdot}44554$	$\log e' = 964888$

No.	Letters	Miller	φ	ρ	ξ_o	η_o	ξ	η	X′ (Prismen) x : y	y′	d′ $=\operatorname{tg}\rho$
1..........	c	001	90°00′	24°01′	24°01′	00°00′	24°01′	00°00′	0·44557	0·00000	0·44557
2..........	b	010	00°00′	90°00′	00°00′	90°00′	00°00′	90°00′	0·00000	∞	∞
3..........	a	100	90°00′	90°00′	90°00′	00°00′	90°00′	00°00,	∞	0·00000	∞
4..........	m	110	51°06′	"	"	90°00′	51°06′	38°54′	1·2393	∞	∞
5..........	z	120	31°47′	"	"	"	31°47′	58°13′	0·6196	∞	∞
6..........	k	011	32°40′	39°33′	24°01′	34°48′	20°06′	32°24′	0·44557	0·69495	0·82580
7..........	v	021	17°46′	55°36′	24°01′	54°16′	14°35′	51°45′	0·44557	1·3899	1·4598
8..........	i	$\overline{1}01$	$\overline{90}$°00′	22°34′	$\overline{22}$°34′	00°00′	$\overline{22}$°34′	00°00′	$\overline{0}$·4155	0·0000	0·4155
9..........	h	$\overline{2}01$	$\overline{90}$°00′	51°57′	$\overline{51}$°57′	00°00′	$\overline{51}$°57′	00°00′	$\overline{1}$·2776	0·0000	1·2776
10..........	p	111	62°00′	55°57′	52°35′	34°48′	47°01′	22°54′	1·30715	0·69501	1·47977
11..........	y	$\overline{1}11$	$\overline{30}$°54′	39°00′	$\overline{22}$°35′	34°48′	$\overline{18}$°51′	32°41′	$\overline{0}$·41591	0·69501	0·80978
12..........	g	$\overline{3}12$	$\overline{67}$°41′	42°28′	$\overline{40}$°15′	19°10′	$\overline{38}$°39′	14°51′	$\overline{0}$·84656	0·34758	0·91526

With very few exceptions the inyoite crystals conform to one or the other of two well-defined types.

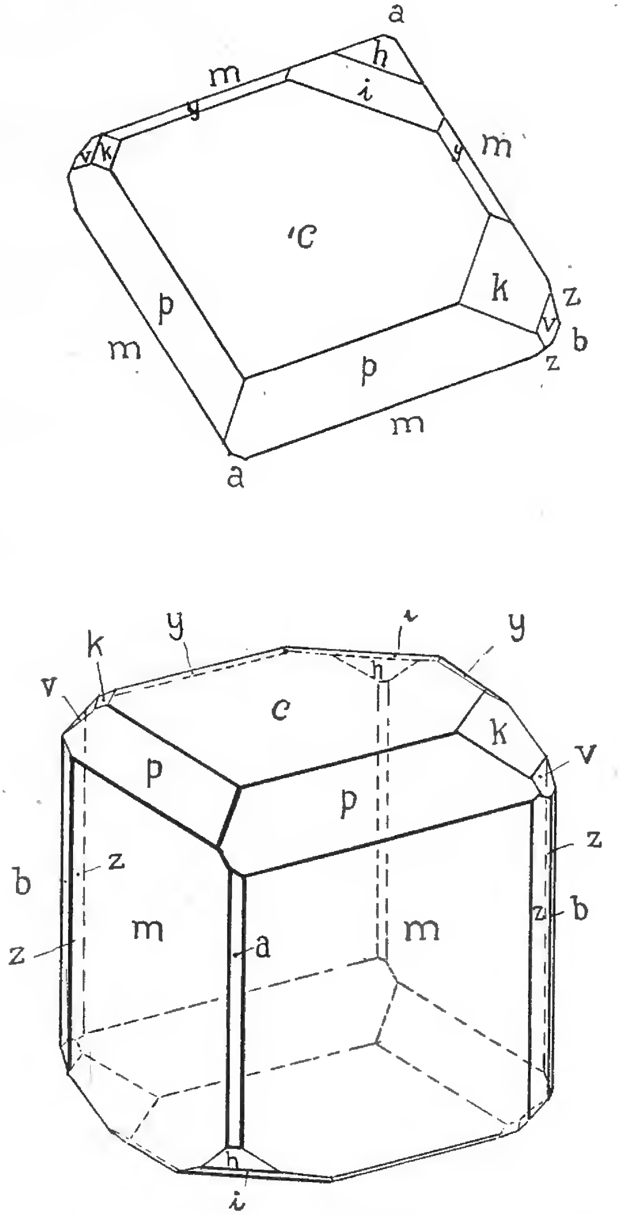
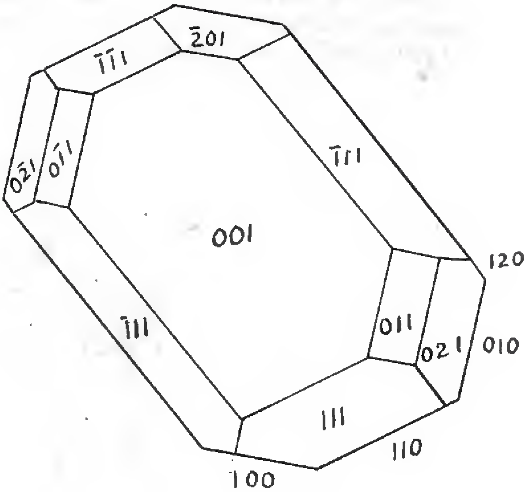


FIGURE 2. Common habit of inyoite from Hillsborough, N.B.

Type I. Crystals of this type (see Figures 2 and 3) are always doubly terminated, and exhibit a broad development of the unit prism m (110) with corresponding limitation of the basal pinacoid; the clinopinacoid b (010), the orthopinacoid a(100), and the clinoprism *z*(120) are reduced to narrow forms. The clinodomes and the negative orthodomes are of medium proportions.

Individuals of this type are to be found amongst crystals of all sizes, but the largest crystals—those ranging from 7 to 10 millimetres in diameter—are exclusively of this character.



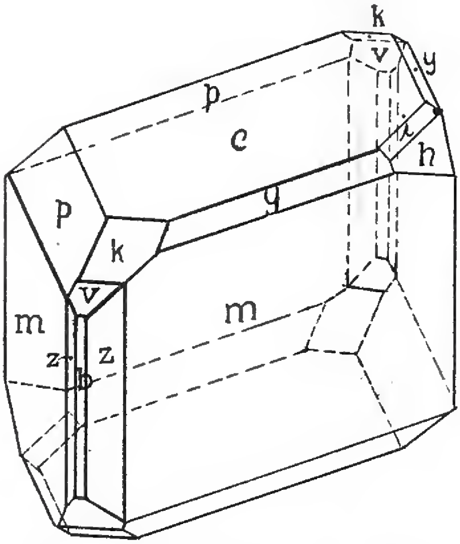


FIGURE 3. Crystal drawn with the clinopinacoid b(010) facing observer.

Type II. Crystals of this type (see Figure 4) differ from those of type I in that the clinopinacoids and the orthopinacoids become dominant faces and the unit pyramids, also, attain to larger proportions. The type embraces certain of the smaller individuals and none have been noted having a diameter in excess of 4 millimetres or a length in excess of 7 millimetres.

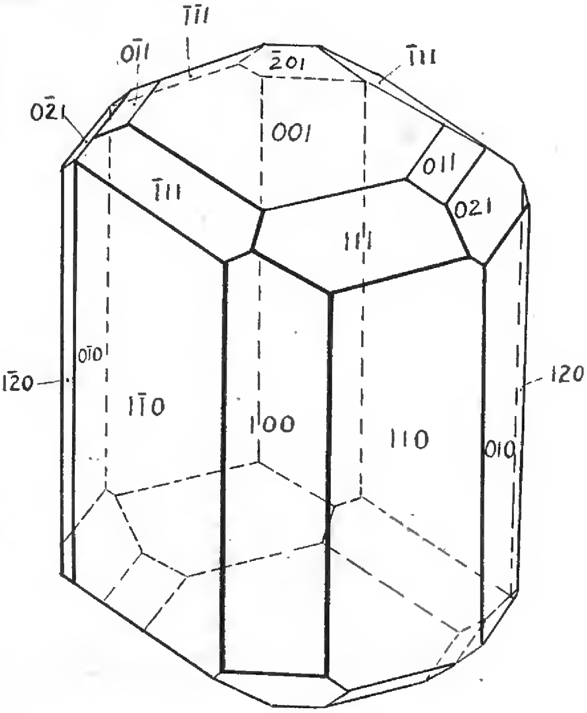


FIGURE 4. Crystal slightly elongated in the direction of c-axis.

A very few small crystals have been observed which do not strictly correspond with either of the types described, and owing to variations amongst themselves they cannot be formed into a separate group. Examples of this kind are illustrated in Figures 5 and 6.

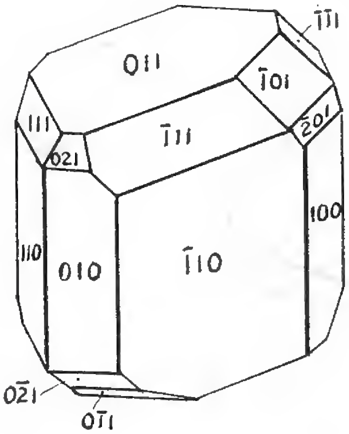


FIGURE 5. Crystal slightly different from the common habits.

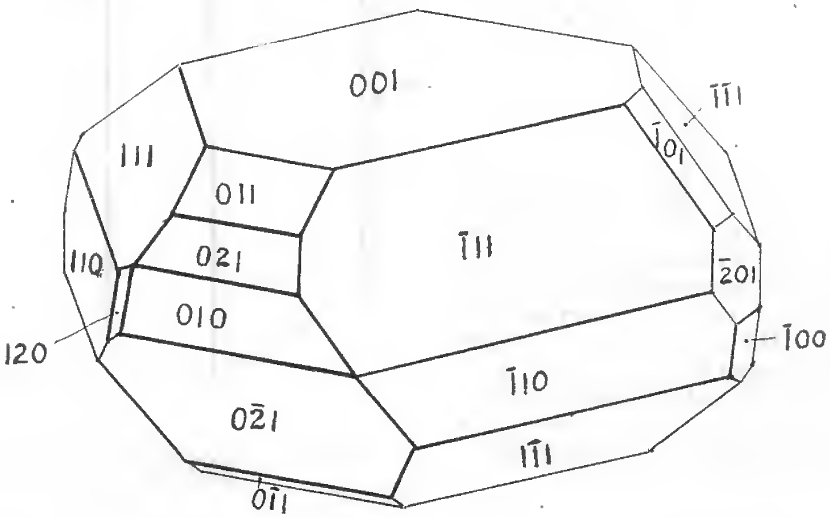


FIGURE 6. Crystal slightly different from the common habits drawn with the clinopinacoid facing the observer.

Table Summarizing the Two Principal Habit Types.

	Type I	Type II
Large forms	m(110) c(001) p(111) y($\bar{1}$11)	m(110) c(001) p(111) y($\bar{1}$11) a(100) b(010)
Long narrow forms	a(100) b(010) z(120)	.... z(120)
Medium to small forms	k(011) v(021) i($\bar{1}$01) h($\bar{2}$01) g($\bar{3}$12)	k(011) v(021) i($\bar{1}$01) h($\bar{2}$01) ......

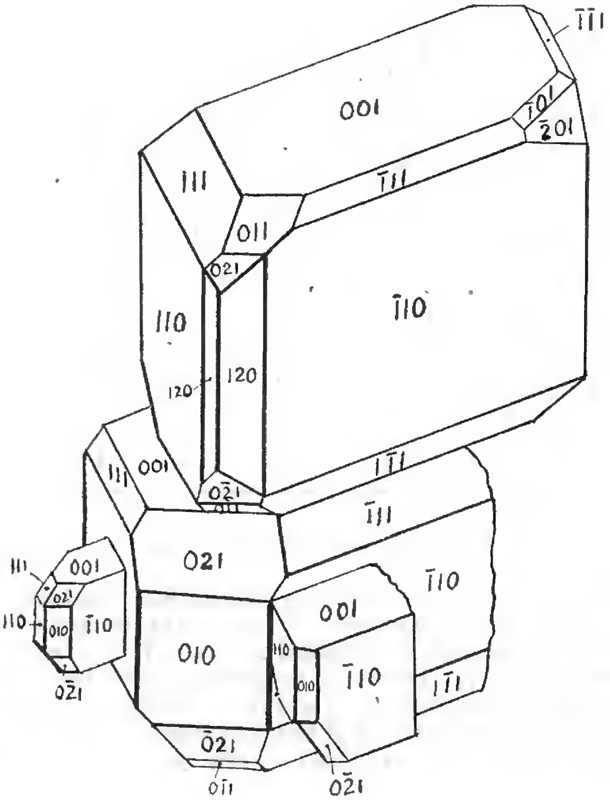


FIGURE 7. Parallel growth of crystals drawn with the clinopinacoid facing the observer.

No examples of twinning have been observed amongst the material that has been available for examination. The crystals do, however, show a persistent tendency toward parallel development which has resulted in the formation of peculiarly handsome groups as illustrated in Figure 7.

Inyoite.

Table arranged to show the combination of forms on the nineteen measured crystals.

Letters	Symbols	1 Crystal	2 Crystal	3 Crystal	4 Crystal	5 Crystal	6 Crystal	7 Crystal	8 Crystal	9 Crystal	10 Crystal	11 Crystal	12 Crystal	13 Crystal	14 Crystal	15 Crystal	16 Crystal	17 Crystal	18 Crystal	19 Crystal
c	001	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
b	010	+	+	+	+	+	+	+	+	+					+		+		+	
a	100	+		+			+	+		+							+	+	+	
m	110	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
z	120		+	+	+		+			+	+	+	+	+		+		+		
k	011	+	+		+	+	+	+	+	+	+	+	+	+	+	+		+	+	+
v	021	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
i	$\bar{1}01$		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
h	$\bar{2}01$	+	+	+	+	+	+	+		+					+		+	+	+	
p	111	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
y	$\bar{1}11$	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
g	$\bar{3}12$		+																	

OPTICAL PROPERTIES.

Several trials were made to determine the optical characters, using some of the larger crystals; these, however, did not yield satisfactorily concordant results owing, it is presumed, to included individuals of selenite.

It became necessary, therefore, to select a number of the smaller crystals whose purity was beyond question. Wulfing's[1] method was employed for determining the position of the optic axial angle, the intermediate index having previously been obtained by the total reflection method.

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[1] E. A. Wulfing, f. Kryst, 36, 1902, 402–407.
H. Rosenbusch and E. A. Wulfing, Physiography, 1st part, pp. 326–327.

The axial plane is parallel to b(010) Figure 8. The birefringence is strong and negative. The dispersion is weak apparently $\rho < V$. The acute bisectrix (Bx_a) lies in the obtuse angle between the *a* and *c* axes and is inclined 12° 56′ from the normal on c(001) and 37° 13′ from the c—axis; $2V_a = 80° 33'$. One of the optic axes emerges through c(001) at an inclination of 27° 21′ from the normal; the other emerges through a(100) at an inclination of 12° 31′ from the normal. $\beta = 1 \cdot 501$.

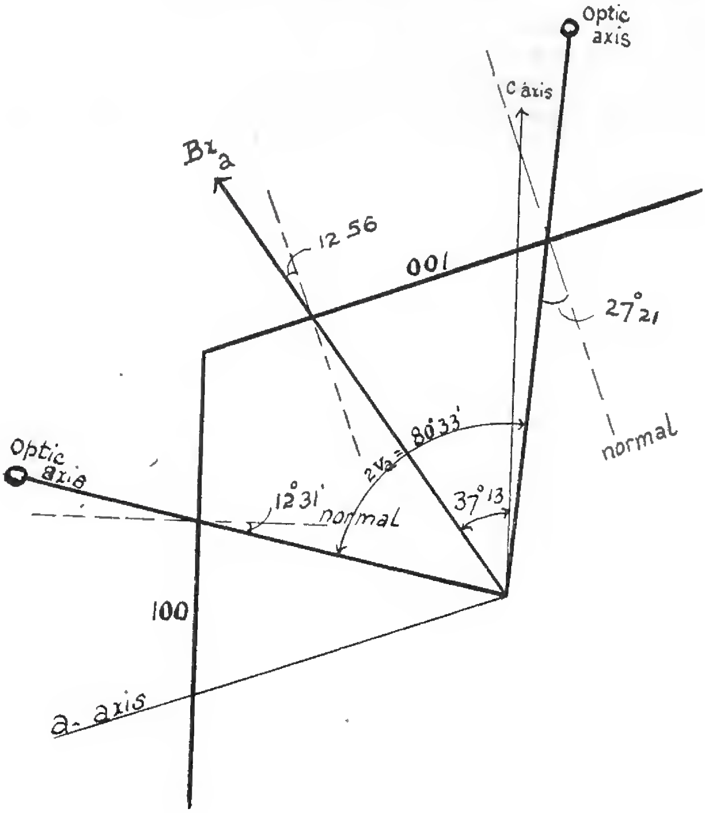


FIGURE 8. Showing the optical orientation of inyoite.

These measurements were made in the mineralogical laboratory of McGill University, Montreal, and the writer wishes here to record his thanks to Professor R. P. D. Graham in charge of the laboratory for the use of his instruments and his kindly co-operation in this connexion.

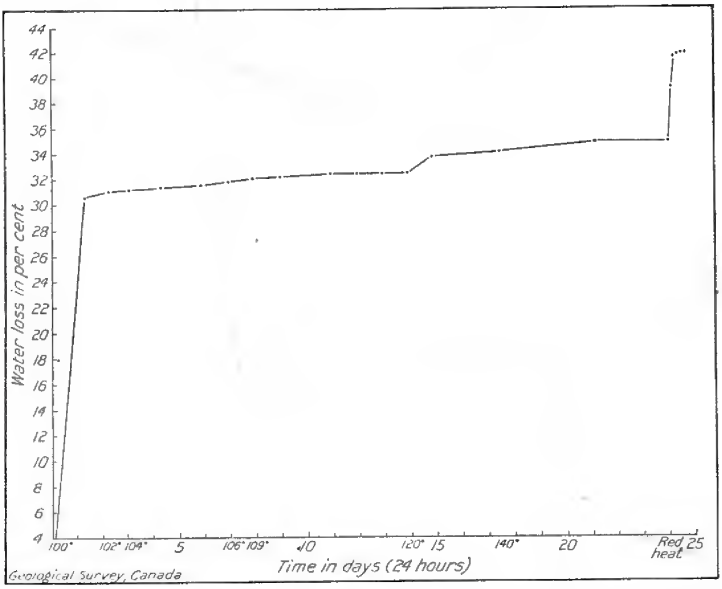
CHEMICAL PROPERTIES.

Pyrognostics. A splinter of the mineral held well above the flame of a candle or alcohol lamp becomes white and opaque, lowered into the tip of the flame it melts readily to an opaque white globule, hence fusibility 1 or less. A fragment heated before the blowpipe first crumbles and becomes opaque white, then fuses with intumescence due to the volatilization of B_2O_3 to a glass which is clear and colourless while hot, white and opaque when cold, the blowpipe flame being coloured a strong green by the escaping B_2O_3.

Solubility. The mineral is readily soluble in dilute acids and fairly soluble in water. When clear, transparent fragments are placed in water and heated to boiling temperature on the hot water bath they become white and opaque, apparently losing water just as when heated in air. This instability in the presence of water at 100 degrees would seem to indicate a low temperature of formation for the mineral and is in agreement with its mode of occurrence as crystals associated with and later than selenite lining vugs in the gypsum masses.

CHEMICAL ANALYSIS AND COMPOSITION.

The sample for analysis consisted of clear, transparent crystals and crystal aggregates which were carefully examined under a binocular microscope for intergrown or attached selenite. Many of the crystals examined showed inclusions of minute selenite crystals and as these have the same index of refraction as inyoite and are also clear and transparent, they are very difficult to detect, so that in spite of the care exercised in selecting the material, analysis revealed the presence of about one per cent of selenite.



Geological Survey, Canada

FIGURE 9. Graph showing water loss of inyoite on heating at increasing temperatures.

The sample was crushed by impact to 80 to 100 mesh on a polished steel plate, using a flat-faced steel pestle, any grinding motion of the pestle being carefully avoided, owing to the possibility of loss of water. After thorough mixing, several portions were weighed out at once and the water determination started immediately. A half gram portion in a platinum crucible was heated in an electric oven at an initial temperature of 100 degrees and weighed from time to time after cooling in a desiccator over sulphuric acid, the results being indicated graphically in Figure 9. In this case 30·66 per cent of water was lost in the first thirty hours at 100 degrees C. The temperature was then gradually increased as indicated on the graph, the oven being set so that these temperatures were never exceeded for the periods indicated, though there might be a fall of 2 or 3 degrees from time to time. At 109 degrees C., constancy of weight was attained after a loss of 32·46 per cent which four days additional heating failed to increase. It may be noted that this loss considerably exceeds that found by Schaller[1] (26·1 per cent below 110 degrees) for the original inyoite. The difference may possibly be due to longer heating of the Canadian inyoite. After heating to constant weight at 140 degrees in the oven, the covered crucible was placed on a triangle inside a larger iron crucible, so that the platinum crucible was distant about 1 centimetre from the bottom and walls of the iron crucible, and the latter was heated gradually to a red heat. By this procedure the mineral was slowly but thoroughly sintered and no loss of B_2O_3 was detected. Constancy of weight was reached after seven two-hour periods of heating, the loss, 41·92 per cent, being accepted as the best value for the total water. Another half gram portion was heated in the same oven at a constant maximum temperature of 105 degrees. After six days the loss was 32·40 per cent and after eleven days 32·44 per cent, with no more loss on further heating. The long time required to drive off the last 1 or 2 per cent of water below 110 degrees was no doubt due to the presence of relatively coarse particles in the crushed material used. A sample of uniform grain size would be necessary for strictly accurate results. After the loss of 30 per cent of water the material becomes decidedly hygroscopic and the rate of loss will evidently depend to quite an extent upon the humidity of the air entering the oven. The sample which had lost 32·44 per cent of water gained 11 mg. in weight on standing in a covered crucible for four hours in the balance case. Other methods of determining the total water were also used and yielded fairly concordant results. Using a Penfield tube with lime as a retainer 42·01 per cent water was obtained. The modification of the ordinary Penfield tube method which was used might be noted here. When large amounts of water are determined in the Penfield tube there is difficulty in holding the water with the usual plain or bulb forms. The writer substitutes for the bulb a plug of glass wool which holds the water like a sponge by capillary attraction. The plug is prepared in advance by inserting a sufficient amount of glass wool into an open

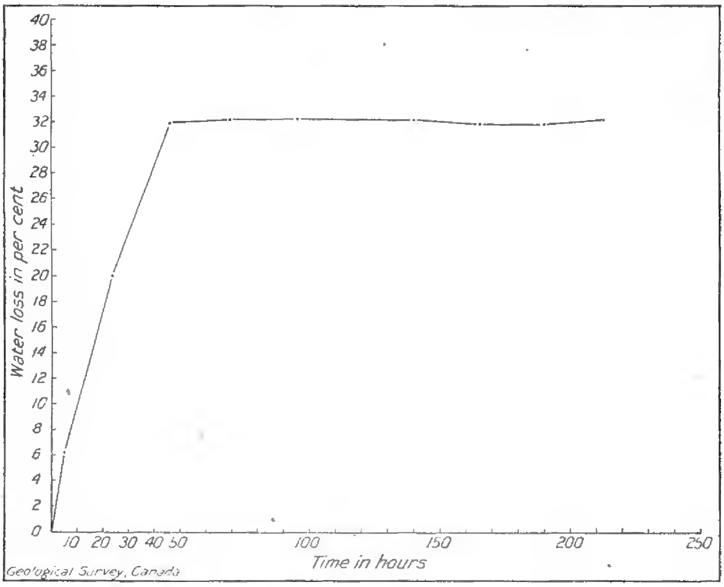


FIGURE 10. Graph showing water loss of inyoite on heating at 110 degrees C.

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[1] U. S. Geol. Surv. Bull. 610, p. 39.

tube of the same size as the Penfield tube. After drying in the oven the plug is removed from the open tube and may be readily inserted into the Penfield tube by means of tweezers. A plug above the mineral powder in the bottom of the tube is also an advantage, preventing any carrying over of solid particles with the water, and may be sealed off with the mineral powder. The capped tube containing the water is weighed against another tube as nearly as possible similar in size and weight, which has been heated at one end in the same way as the tube containing the water. Gradual ignition in a crucible with lime as a retainer gave 42·13 per cent, but on further and more intense ignition a loss of B_2O_3 was observed. The failure of the lime to retain all the B_2O_3 was probably due to the mineral not being in a sufficiently finely divided condition to secure the necessary intimate contact with the lime, fine grinding being inadvisable, and perhaps partly also to too rapid heating. Ignition with fused litharge also gave high results, probably for the same reasons.

Figure 10 shows the loss on heating of a different sample from No. 1 in a different oven. In this case the regulator was set for a maximum temperature of 110 degrees C. throughout the whole period, but the temperature on one occasion was observed to rise to 115 degrees for a short time. The slightly different behaviour of the two samples may be accounted for by differences in the gypsum content, in the initial temperatures, and in the air circulation of the two ovens.

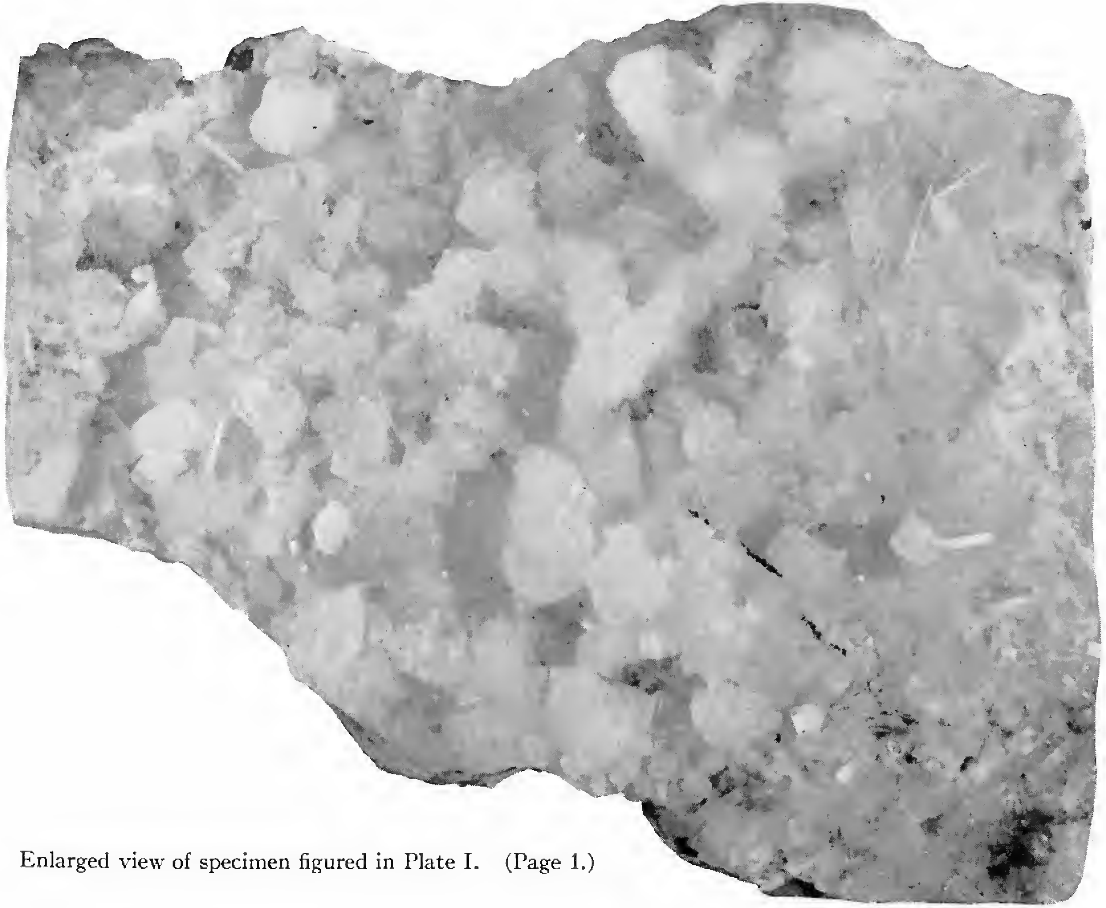
Lime was determined after volatilization of B_2O_3 as methyl borate by precipitation as oxalate in dilute acetic acid solution and weighing as oxide. It might be mentioned that C. P. Absolute Methyl Alcohol from a prominent maker was found to contain lime and tarry substances and had to be redistilled before using. Boron trioxide was determined by the Gooch method of distillation as methyl borate and fixation in lime. Silicon, aluminium, iron, magnesium, fluorine, carbon dioxide, and phosphorus pentoxide were sought with negative results. The results of the analysis are tabulated below:

	Analysis	Ratios	Gypsum	Inyoite		Theoretical
	%					%
CaO............	20·42	0·3642	0·0069	0·3573 or	2·000	20·18
B_2O_3............	37·44	0·5364		0·5364	3·002	37·68
SO_3.............	0·55	0·0069	0·0069			
$H_2O-110°$.......	32·46	1·8013	0·0138	1·7875	10·032	32·42
$H_2O+110°$.......	9·46	0·5249		0·5249	2·938	9·72
	100·33					100·00

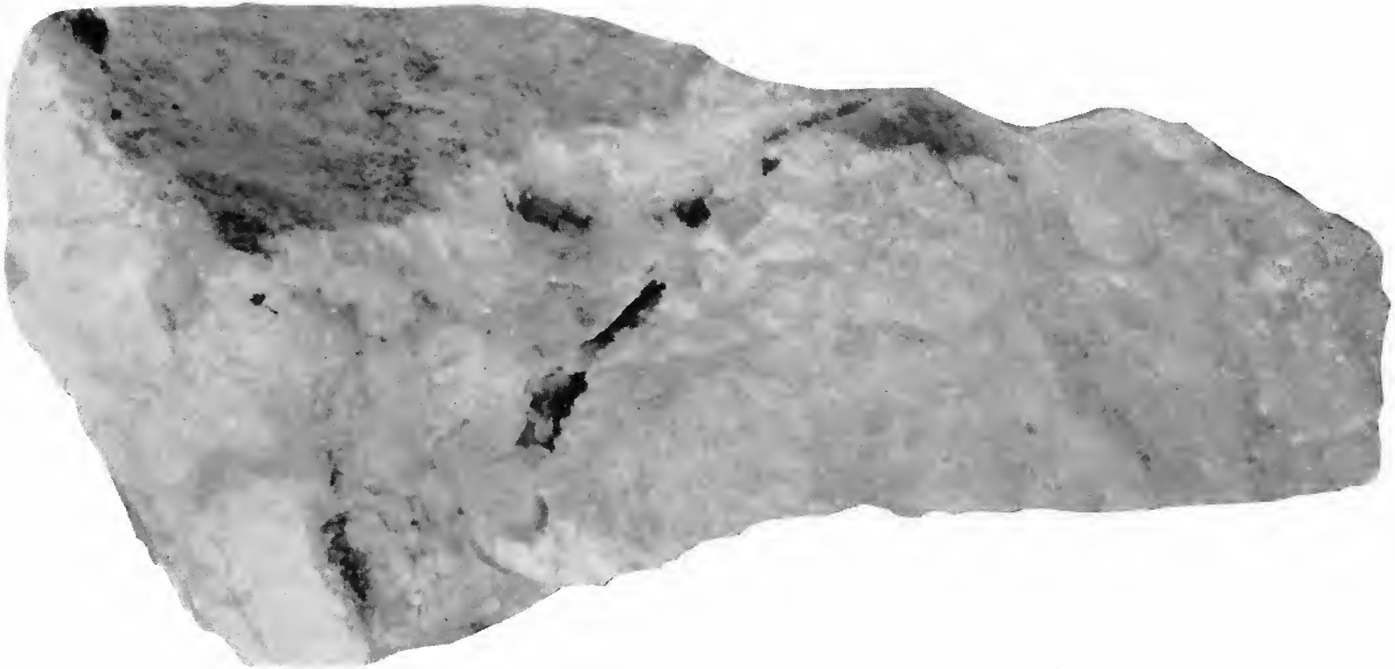
The international atomic weights for 1920 have been used in all calculations. The total water calculated as belonging to gypsum has been subtracted from the total water below 110 degrees, since gypsum loses all its water below 100 degrees on prolonged heating (Gmelin-Kraut II 2,235).

The analysis agrees well with Schaller's analysis of the original inyoite, except as regards the water below 110 degrees, this probably being due to a difference in the length of time of heating. The formula indicated by the above analysis is $2CaO.3B_2O_3.13H_2O$ or $2CaO.3B_2O_3.3H_2O+10H_2O$.

The specific gravity of the mineral determined by the pycnometer method was 1·885 at 24·5 degrees C. This is slightly higher than Schaller's figure 1·875, which might be expected owing to the presence of gypsum (sp. gr. 2·32).



Enlarged view of specimen figured in Plate I. (Page 1.)



Another view of specimen figured in Plate I, showing fissures partly filled by inyoite crystals.
(Page 1.)